Fabricating and Installing Side-Lap Roof Shingles in Eastern Pennsylvania

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In order to restore some of Pennsylvania's historic buildings, the authors are recovering a lost trade practice.

Over the past decade of working on side-lap-shingle roofs, the authors have observed many earlier attempts by others to make the process of replicating these roofs faster and less expensive. These attempts have included substituting materials, sawing and planing shingles rather than riving them to speed the manufacturing process, and adding other materials between courses to reinforce the roofing system. All of these attempts have saved money and time in the short term but have failed to perform long enough to realize the savings.

During these investigations the authors have demonstrated the craft of shingle making at Pennsylvania Historical and Museum Commission sites and other public venues and have trained roofing contractors to install side-lap shingles (Fig. 1). In so doing they have tested materials, traditional tools, folklore, and their own ideas. Working from and expanding upon the foundation of research conducted by Robert C. Bucher in the 1960s, the authors have recovered an important traditional craft and trade practice.[1] This article highlights that craft and the venues where it has been applied. A glossary of relevant terms appears at the end of the article.

Fig. 1. The layout of side-lap shingles makes it relatively easy to work to a vertical edge. Nineteen-year-old western red cedar shingles are being replaced with handmade red oak shingles at the Saal, or meetinghouse, at Ephrata Cloister. Because the courses of side-lap shingles are not staggered, the roofers are able to work to a straight, vertical edge from the eave to the ridge of the roof, making it much easier to tear off and replace roofing on buildings of this size. All images by the authors.

Historical Background

Ephrata Cloister, located in Ephrata, Lancaster County, Pennsylvania, was founded in the 1730s by Conrad Beissel, who was born in Eberbach am Neckar, Germany, in 1691 and immigrated to Pennsylvania in 1720. In fact, *cloister* is a contemporary misnomer, for Ephrata was the center of the community at large. Beissel's charismatic theology encompassed piety, mysticism, and Sabbath worship and encouraged celibacy yet made room for families, limited industry, and creative expression. The community became known for its a cappella music, Germanic calligraphy, and a complete publishing center, which included a paper mill, printing office, and book bindery.

Beissel had found himself in conflict with the State-supported Protestant church in Germany at the end of the Hundred Years War and moved to Penn's colony to find religious tolerance. He lived in Germantown, near Philadelphia, for a year and then moved to the Conestoga region, near Lancaster, Pennsylvania. There he associated with an Anabaptist group, the Brethren. In 1724 Beissel was appointed leader of the Conestoga Brethren Congregation. In

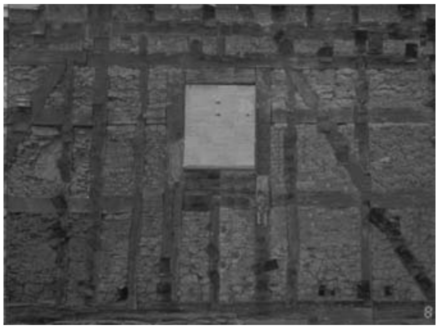

Fig. 2. The north gable end of the Saal at Ephrata Cloister during a siding-restoration project in 1998. This image shows typical eighteenth-century fachwerk, or half-timbering, with limestone and clay nogging. The scaffold has been edited out of the digital scan.

1728 Beissel withdrew from the congregation and eventually sought solitude and celibacy along the banks of the Cocalico Creek. He was soon followed there by like-minded men and women. His hermitage grew to a community of nearly 80 celibate men and women and 200 family members from the region. From 1735 to 1746 the community erected no fewer than eight major structures, including dormitories and meetinghouses, and numerous smaller dwellings, workshops, and mills.

The society declined after the death of its charismatic leader in 1768, and the last celibate member died in 1813. The remaining members formed the German Seventh-day Baptist Church. By 1929 the congregation fell into internal disputes, and the various factions initiated legal action against each other. The court eventually placed the cloister property under the care of a receiver, who in 1941 sold the property with its nine surviving original buildings to the Commonwealth of Pennsylvania. The State immediately embarked on a restoration campaign, headed by architect G. Edwin Brumbaugh. After Brumbaugh left the project in 1960, most of the interior spaces were restored under the direction of architect John Heyl. Today, this National Historic Landmark is administered by the Pennsylvania Historical and Museum Commission and is open to the public.

Materials and Tools for Shingle Making

Most of the surviving buildings at Ephrata are of log or half-timber (fachwerk) construction (Fig. 2). While they are widely regarded as medieval in character, they are actually typical examples of plain mid-eighteenth-century construction practice. The buildings are clad with hand-riven oak clapboard siding and roofed with hand-riven, highly finished oak side-lap shingles. Side-lap shingles are commonly found in eighteenth- and nineteenth-century German settlements throughout Pennsylvania and follow the German Diaspora through Maryland down the Shenandoah Valley and into North Carolina. The shingles possess several distinctive features: they are long (up to 48 inches) and narrow (as little as 4 inches); they lap side to side, as well as butt to tip; and they are face nailed with a single nail near the butt of each shingle. Side-lap shingles were found by architect G. Edwin Brumbaugh in at least one building, and he identified them as roofing and siding shingles. An early postcard depicting the Saron, or the Sisters' House, shows shingle siding on the upper gable end, although it is impossible to tell from the image what type of shingles they are. The specimens, with Brumbaugh's labels, are in the collection at Ephrata Cloister.

Most of the original eighteenth- and nineteenth-century shingles the authors have seen in settlements with a German cultural influence are made of red oak. Recent reproduction shingles have been made from both red and white oak, and northern red oak usually provides the best results. The contemporary argument in favor of white oak as the wood of choice for shingles is based on its density and water resistance. None of the other species widely used for shingles (western red cedar, eastern white cedar, white pine, chestnut, cypress) is as hard or as waterproof as white oak. Those qualities make white oak superior for things like cooperage and sill plates in buildings, but these qualities also make white oak highly reactive to cycles of wetting and to drying in sunlight. The sapwood of red oak is off white and 1 to 2 inches thick, and the heartwood is reddish brown. The shingle grade of red oak is heavy and straight-grained; it splits well and works well with the drawknife. In contrast, white oak, when riven, tends to be stringy (pulling fibers out along the grain) and is harder to work with the drawknife when green or dry. It is faster and easier, and therefore more cost-effective, to make shingles out of red oak. White oak also tears out when riven, so if a 1/4-inch-thick shingle has 1/8 inch of tear out, the final shingle is, in effect, only 1/8 inch thick.

Traditional shingle making is done with simple tools: a sledgehammer, steel wedges, root maul, gluts, axe, froe, mallet, shingle brake, shaving bench,

Fig. 3. An array of tools used to make shingles, left to right: wedges and a small sledge; a maul and gluts, on a halved shingle log; riving brake with a shingle bolt, mallet, and froe; hole punch with a shingle under the retainer, ready to punch; a shaving bench and drawknife with a shingle clamped under dumb head; and the scrap pile. Bertolet House, the larger log building in the background, was reroofed in 2007.

drawknife, nail hole punch, sorting bench, and clamps (Fig. 3). The sledgehammer should weigh 4 to 8 pounds, the exact weight depending on the strength of the user; it is used for driving the steel wedges into the log. The root maul is used to drive gluts, simple wood wedges that are 4 to 6 inches thick (driving a glut with a steel hammer will shatter it). Gluts can be made from whatever wood is at hand; dogwood, sycamore, elm, and locust make durable gluts. The gluts are driven into a crack started by the steel wedges, which are too small to drive the halves and quarters of a large log apart. Steel wedges are necessary for the initial split.

The froe mallet should be light enough to use comfortably but heavy enough to drive the blade of the froe into the shingle bolt. A bolt is one-eighth to one-sixteenth section of a round log. Hickory is a good wood for mauls and mallets; the lowest part of the stem, including the root cluster just below ground, is used for both.

The shingle brake is a simple vise used to hold the bolt when riving it into shingles. A tree crotch makes the traditional shingle brake; ash is the best choice because of its narrow crotches (25-degree inside angle).

The shaving bench is a simple foot-actuated clamp used to hold the shingle when working with the drawknife. The shaving bench needs a workspace behind the dumb head (clamping head) slightly more than half as long as the shingle, to support the shingle and prevent the drawknife from skipping when working the shingle. Although many antique drawknives survive, the authors have not found one that can be positively identified as having been used specifically for shingle making. However, based on experience and experimentation, the best results are achieved using a drawknife that has a blade about 10 inches wide, with handles 7 inches from the blade. The overall length of the drawknife used for Pennsylvania Historical and Museum Commission projects is 24 inches. The angle of the hand grips, which are pitched below the plane of the blade, allows the shingle maker to use full arm and back strength while slicing and cleaving the wood.

Selection of the log is crucial to the production of shingles (Fig. 4). The part

Fig. 4. Five side-lap shingles found in the Dunkard Meeting House in Pricetown, Pennsylvania, built about 1777. These shingles are red oak, 5 to 5 1/2 inches wide, 34 to 36 inches long, and 3/8 to 5/8 inches thick. They were never installed and were found in a cupboard next to the kitchen fireplace. Some of their mates may have been used for kindling. These shingles are about 230 years old.

of the log that comes from the first 2 to 4 feet above the soil should be avoided because of the flare at the stump. When inspecting logs at the dealer's yard, look for a uniform character to the bark, and peel off enough bark to check the slope of grain. A spiral pattern in the bark guarantees that the grain of the wood will also spiral; unfortunately, a straight pattern in the bark is no guarantee of straight grain of the wood, but the edges of the medullary rays that appear on the exposed cambium layer under the bark are a reliable indicator of the grain character of the wood.

Shingle-grade wood, which is a grade better than veneer, must be free of twist and as clear as possible. An oak shingle with twist is hard to nail down, and the spiral increases from course to course through the roof.

Fabricating the Shingles

Splitting bolts from the log is somewhat similar to splitting firewood. The first step in splitting off bolts is scoring straight across the log with the steel wedge before starting to split the log. The score line directs the split and ensures flatter cleft surfaces on the bolts. The log is cut to shingle length and split to halves, quarters, and eighths, and the heartwood and sapwood are split off. On older shingles from historic sites the sapwood was left on during the riving and then sliced with the drawknife from the weathering (lower) part of the shingle, leaving the characteristic stop chamfer on the thick edge.

The bolts are reduced to shingle stock with the froe. The bolts must always be split in half to keep stresses in the wood equal so that the crack runs straight. When riving with the froe, the split may run toward one surface. If the split goes off track, the thicker of the pair of bolts or shingles is bent. Bending stresses the wood, and the crack runs into the stressed section of the wood. In this manner the direction of the split can be controlled so that the shingles riven from the wood are straight. Because the shingle stock is split radially, it usually has a narrow, pie-shaped side taper when it is riven.

Next, the shingle stock is reduced to a finished shingle using the drawknife at the shaving bench. The shingle thicknesses range from 5/8 inch to 1/4 inch at the butt to a feather edge at the tip and thin edge. (The only archaic term the authors have found for side-lap shingles is *fedda schindla,* or "feather shingles," in Pennsylvania German.) All surfaces are worked with the drawknife to ensure accuracy of mating surfaces. Dressing the entire surface also removes any tear out and, in effect, gauges the shingle, serving as one of the measures of fitness for use. The shingle laps in two directions, and the smooth surfaces are required to form good edge-to-edge contact and prevent stress cracking the shingles during installation.

Next, shingle stock is moved to the hole punch (Fig. 5). The hole punch is mounted on a bench or a plank and has a retainer to hold the shingle down when the hole-punch bit is withdrawn. The retainer is supported on two strips of wood mounted at right angles to each other. These strips index the location of the nail hole. The retainer also serves as a thickness gauge; if the butt will not slide under the retainer, it goes back to the shaving bench. The shank of the nail-hole bit should be strong enough to prevent its bending, and the holes

Fig. 5. An antique hole punch from the collection of John Fugelso. A hole punch is used to make the nail hole in each shingle.

Fig. 6. A spade-pointed nail and freshly punched shingle; the working end of a hole punch is at the right.

should be punched when the shingle is green. The punch has a sharp edge that cuts across the grain and matches the width of the shank of the shingle nails (Fig. 6). Punching in this way relieves splitting forces in the shingle and leaves severed fibers in the hole, which form a tight seal around the nail when it is inserted later.

After the holes are punched, the shingle is transferred to the sorting bench to be sized and bundled. The width tolerance is 1/2 inch more or less than the nominal measure. The bundle of shingles is assembled by stacking the shingles thin edge to thick, tip to butt, alternating to form a rectangular block. The shingle bundle is clamped as tight as possible and tied with twine. Bundling shingles in this manner lessens twisting and warping during drying and also saves time during the installation, as the roofing crew does not have to sort and size the shingles.

The shingles should be made with green wood. Shingle logs can be kept in ponds to prevent drying out. If shingles become dry, they can be soaked until completely saturated. Red oak shingles will soak up water faster than white oak, making them easier to use. One roofing contractor working on historic projects in Pennsylvania used an inexpensive children's wading pool to reconstitute red oak shingles. The soaking will not harm the shingles or the bolts.

A Word about Sawing Shingles

Some contractors have attempted to reduce the cost of oak side-lap shingles by sawing the stock to rough shape and then planing the double taper in a jig. A shingle can be sawn and planed from any wood, but it is impossible to rive a straight shingle out of stock that does not have straight grain The failures that result illustrate the importance of riving, rather than sawing; riven shingles are a much higher-quality product. For a hardwood shingle to remain flat on the roof, the grain of the stock must be perfectly straight and flat. If it is not, the shingle will warp as it goes through wetting and drying cycles, in effect returning to its natural shape. Although the superficial appearance of a sawed shingle may be similar to that of a riven shingle, sawing through deviating grain can expose more fibers to wetting and rot organisms and, in extreme cases, allow portions of the wood to crack and fall off. The argument against sawing shingles has been going on as long as there have been shingle mills.[2]

Shingle Production Rates

A question the authors are asked frequently is how many shingles can be produced in a day. There are folklore accounts that claim that some former practitioners were able to produce 600 to 1,000 shingles per day. These accounts do not specify a type of shingle, and side-lap shingles are relatively highly finished. Based on the experience of recent projects, such production rates for side-lap shingles would be brutal, even with perfect shingle stock and no finishing steps beyond riving and throwing shingles on a pile. David Dauerty, a timber framer from Constantia, New York, who has produced thousands of side-lap shingles and more than 10,000 linear feet of hand-riven oak clapboard siding for projects at the Ephrata Cloister, can rive 150 shingles a day on average. His best rate was about 360 per day. These rates are for riving only, from bolts of oak already split from the log. Rates for finishing with the drawknife are 50 to (rarely) 90 per day, including cleanup. Dauerty has made a substantial investment in modern equipment to speed the rough splitting of stock into bolts, mainly with a custom hydraulic log splitter with an extra broad wedge and a 4-foot bed. He sorts the shingles by width and bundles them with a banding machine, then documents how many bundles of each size he delivers, which is an important aid to the roofers in planning their work, as will be seen below.

The Installation Process

A side-lap shingle system requires a good substrate. Reusing old oak shingle-nailing lath presents two problems. First, the lath must be straight and level. Historic buildings frequently have hand-hewn rafters that are out of plane, in which case the lath may need to be shimmed out to achieve a relatively smooth, level plane to work on. If one lath is lower than the others, the shingles will bridge over the low point and the nails will not engage the lath. Over time those nails will work loose. The other problem is that old oak lath becomes very hard over time, and getting nails to penetrate the lath is difficult. Furthermore, extra force must be used to drive the nails, and the shock contributes to splitting the shingles. When the shingle costs as much as $10 to $12 each (before installation), the last thing desired is a ruined shingle. Therefore, it is less expensive to replace old, hard lath with green oak, cypress, or pine.

Another concern is that when working on a museum building, consideration must be given to caring for the building as a historic artifact. Cypress is generally a better choice for lath, because it is easier to drive the nails into when the next major maintenance cycle comes up and a new roof is required. When nailing is easier, less shock is transferred to fragile building fabric immediately below the roof. Several of the buildings at Ephrata have a fragile pale-and-daub deafening system between the rafters, which is 260 years old. When the roofs on these buildings were repaired, the dry oak lath was replaced with cypress, and the roofing contractor nailed it in place pneumatically, resulting in a manifold decrease in nailing shock.

The starter course is only double for side-lap shingles (Fig. 7). Modern wooden shingles, which do not lap along their sides, require three layers of material to prevent leaking. This requirement also dictates that no more than one-third of the length of the shingles be exposed to the weather in the field of the roof. Triple starter-course applications are not desirable with side-lap shingles, because they create a stack of wood up to 3 inches thick, requiring nails that are too large. In such cases, the tips of shingles on the second, third, and even fourth courses have to be nailed down to pull the stack of shingles flat enough to place the face nail. Even with a double starter course it is difficult to get the second and third course to lie down on the lath. There are two solutions to the problem: one is to make the tips of the first through third courses feather thin and to select the thinnest shingles. The other solution is to install a kick, or flare, under the first three laths. The height of the kick is about 2½ inches for a 32-inch shingle. The height of the kick can be calculated by laying out and nailing a sample to the third course using the shingles of the job and then measuring how much the first lath has to be raised. The measurement is taken at the tip of the third course shingle and is the distance from tip of the shingle to the lath. Many roofs on eighteenth- and early-nineteenth-century Germanic buildings have a built-in kick at the eave. This kick is most often created by the roof-framing tradition of mounting the rafters in a bird's-mouth seat on the rafter plate so that the arrises of the rafters are flush with the arrises of the plate. Tapered false rafters are then nailed or pinned through a sloping scarf joint to the ends of the rafters in order to extend the eaves beyond the face of the wall below (Fig. 8).

The side-lap shingle replacement project at the Cloister Printing Office used white oak shingles. White oak was selected at the time because of its perceived greater density, impermeability, and toughness. However, nailing the second shingle on the double starter course caused cracking of the shingle beneath it. The problem repeated on successive courses of shingles. There were several contributing factors: shingles too thick, nails too large, wood dry and hard. Other craftsmen who had the same installation problems achieved better results by punching the first shingle and drilling the shingle beneath it with a bit a little smaller in diameter than the nail's thickness. At Ephrata the better solution is thinner shingles and slender nails with a spade-shaped point driven in so that the wide edge cuts across the grain of the shingle. The points of mild-steel clinch nails are cold forged into a spade shape. The nails cut through the lower shingles without splitting them and are fairly easy to drive into the old oak lath.

Nailing

Following historical examples the nails are placed in the lower corner of the shingle on the thick edge, about 1 inch from the butt. There is one nail per shingle, and all nails are exposed. An advantage of this system of installation is the relative ease of replacing individual shingles in the field of the roof; a shingle may be pierced by as many as six nails, but they can all be withdrawn and replaced without disturbing adjacent shingles.

Recent projects at Ephrata have used hand-worked nails with a rose head and tapered point, which were based on

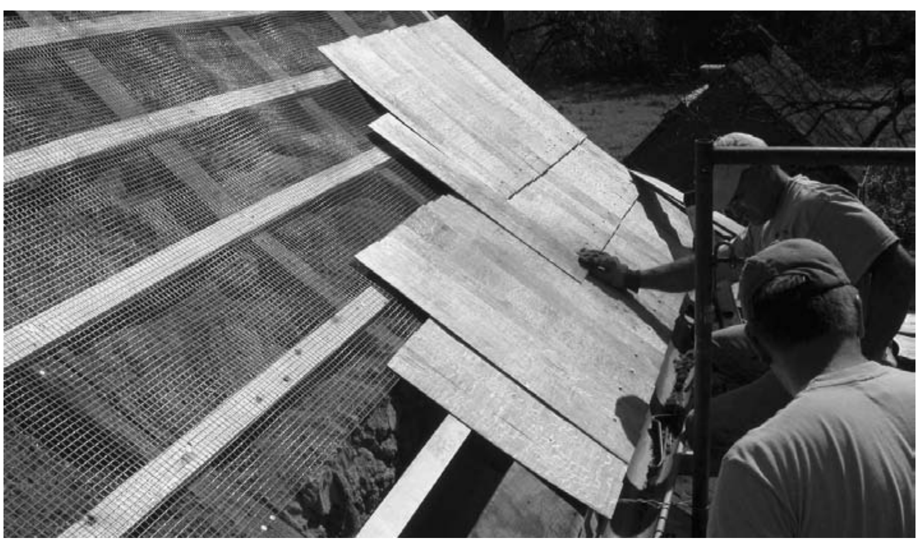

Fig. 7. The Saal, Ephrata Cloister, 2004. The roofers are installing a double starter course of side-lap shingles, with the bottom layer slightly shortened. This shortened course and the kick in the eave make it easier to keep the tips of the shingles down in the first three courses. The ½-inch hardware cloth is used here as a squirrel barrier.

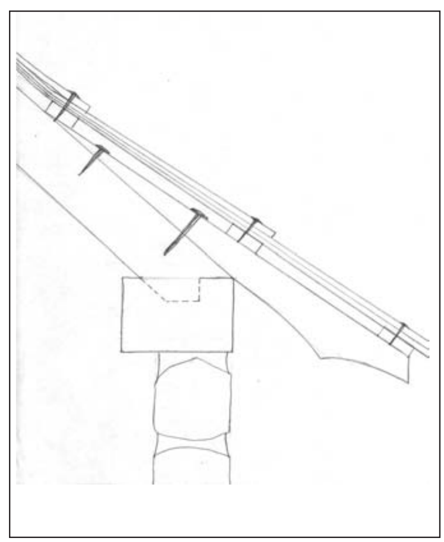

Fig. 8. Detail of the roof on the Bertolet House at Daniel Boone Homestead in Birdsboro, Berks County, Pennsylvania, showing one traditional method of creating a kick at the eave. The rafter is flush with the top plate, and a false rafter is spiked to it, extending the roof beyond the face of the log wall.

examples of hand-forged nails commonly used in the eighteenth century, but these nails have split the shingle below the one being nailed. Traditional roofing nails that the authors found in Virginia in 2004 have a spade point to cut across the grain of the wood in the same manner as the hole punch. As noted above, this approach eliminates splitting. It is possible to cold forge spade points on machine-made mild-steel cut nails as outlined above with eight hammer blows per nail; 100 nails can be treated this way in about 30 minutes.

On later nineteenth-century roofs, machine-cut nails were used, and the nails were often placed higher on the shingle. Most mild-steel cut nails available today are stout in the shank and blunt at the point. These nails are very difficult to drive into hard old lath, and when driven into softwood lath, they sever and crush wood fibers. These nails also tend to release their hold too easily. A nail with a slender shank and a sharp point parts the fibers of the lath without splitting it and has superior holding force. Spade-pointed nails oriented across the grain of the shingles enter the lath parallel to the grain and engage it in the same way as pointed nails.

Rows and Courses

Side-lap shingles are applied in two orientations, courses and rows. Courses are horizontal, running parallel to eave and ridge, and rows are vertical, extending from the eaves to ridge. Shingles in a course will vary in width across the rows. All shingles in a row, however, must be the same width, because they will lap over the next row (Fig. 9). The width of rows should be alternated so that not all the shingles of any given width are used at one time. At some point the distance to the gable end must be calculated against the width of the shingles remaining. Row width will have to be adjusted as the installer gets close to the gable end so that the last row is not too wide or too narrow. At this point it seems that 4 inches should be the minimum shingle side exposure at the gable end.

Similarly, the number of courses to the ridge should be calculated to avoid a too-short top course. The length of the last shingle on the lee side of a combed ridge should be planned to match the exposure to the weather. Shingles at the ridge require two exposed nails. Rows may be installed vertically to the ridge, as long as the first shingle of the double starter course of the next row is in place. It is possible to slide the next course shingle under the installed shingle, as long as the last nail is not driven home. The advantage of this approach is that roofing jacks are not needed. The shingles may be installed with the worker standing on the lath or working from a roofing (or "chicken") ladder hooked over the ridge.

Fig. 9. The Saron, Ephrata Cloister, 2005. Each row, running vertically, contains shingles of like width. Courses run horizontally. Also visible are the kick at the eave and the upward flare of the roof at the side of the dormer created by a tapered fillet board. There is no metal flashing.

Shingle Orientation

It is also important to establish the orientation of the side lap of the shingles: were they lapped to deflect the prevailing wind?

From the experience of the authors' recent projects it does not make any difference in which direction the lap is laid, and there is not enough documentation of intact historic side-lap roofs to indicate cultural, individual, or regional layout styles. At the Printing Office at Ephrata Cloister the shingles were oriented to deflect the prevailing wind, creating a left-hand lap on one side and a right-hand lap on the other. The problem with this layout is that it requires that the orientation of the nail hole be changed for the second half of the roof, and consequently the jig-assembly on the nail hole punch must be reversed. If all of the nail holes are punched with the same jig-assembly set-up of the nail hole punch, the second side of the roof will run opposite from the first side. There is no documentation of how this would have been done historically. If shingles were mass-produced, one would expect that the nail holes would have been made uniformly, in a standard position, to streamline production. The direction in which the shingles are punched also comes into play; it is far more difficult to drive a nail through the shingle opposite the direction that it was punched because the severed fibers crumple and jam in the nail hole. Therefore, it is reasonable to conclude that historically shingles would have been manufactured for installation without regard to the prevailing wind.

At the Traditional Timber Frame Research Advisory Group Conference, held in Shepherdstown, West Virginia, in March 2003, Roger Nair of the Timber Framers Guild took us to the neighboring Wild Goose Farm, founded in 1842, where we inspected the side-lap shingle roof that had survived under old standing-seam sheet-metal roofing. The shingles were riven red oak, measuring 29 inches in length and 1/2 inch in thickness at the butt, tapering to 1/8 to 1/16 inch at the tip, and about the same on the thin edge. They were laid 12 inches on center, and they were not lapped to the prevailing wind direction: the shingles on both sides of the roof lap on their left side. They were fastened with machine-made cut nails. The nails were placed 1 inch from the butt and 1 inch from the thick edge.

Forty-five shingles were salvaged from a pile of shingles that had been stripped from one of the buildings at the farm. The salvaged shingles were randomly selected from those not rotten or broken. The shingles consisted of three sizes: 23 that were 6 to 6 1/2 inches wide; 17 that were 5 to 5 1/2 inches wide; and 5 that were 4 to 4 1/2 inches wide. In each group the majority of the shingles were close to a 4-, 5-, or 6-inch width. The thickness in all width sizes ranged from 3/8 inch to 1/2 inch and was never more than 1/2 inch on all 45 shingles. Both surfaces of all shingles had been worked with a drawknife.

Service Life of Shingles

The one question always asked during shingle-making demonstrations is how long the shingles will last. Several factors affect the service life of wood shingles, including species of wood being used, the substrate (solid or open sheathing), the method of fabrication, the roof pitch, and ventilation from above and below. Experience at the Pennsylvania Historical and Museum Commission (PHMC) shows that a western red cedar roof installed over lath with no tar paper between courses of shingles will last 25 to 30 years. On one PHMC building, a western red cedar roof installed with tar paper between the courses of shingles lasted 13 years. Western red cedar shingles installed on plywood covered with tar paper failed in 15 years. This experience has led PHMC to institute a policy of not using any tar paper between courses of wood shingles, whether they are hand-split cedar or oak side lap, and this is the case in our work at the Ephrata Cloister.

Observations of Side-Lap Shingle Installations

Observing the efforts of others has been instructive in developing an approach to restoring buildings at Ephrata Cloister. The authors have inspected five contemporary side-lap installations at properties owned by other historical societies: an ice house at Belle Grove Plantation in Middletown, Virginia; Wright's Ferry Mansion in Columbia, Pennsylvania; Morgan Log House in Souderton, Pennsylvania; Henry Antes House in Obelisk, Pennsylvania; and the Hans Herr house in Willow Street, Pennsylvania.

The Belle Grove ice house was inspected during a heavy rain in 2001, when there was seepage from cracked shingles. The reproduction white oak shingles were 5/8 to 3/4 inch thick, and the nails were reproduction 4-inch rose heads with heavy shanks and blunt points. The combination of large heavy nails and thick shingles was the cause of the cracking, which occurred where the shingles lapped to the side because of the thickness of the shingle. No tar paper was used, and the small amount of seepage did not seem significant considering how hard it was raining. The ice house was inspected again in July 2006. Damage from ultraviolet light and pulp stripping by wasps and hornets was evident (see *weathering* in the glossary).

The Wright's Ferry Mansion, constructed in 1738 in Columbia, Pennsylvania, had a side-lap white oak roof installed in 1975, and 90-pound rolled asphalt roofing was used between the courses of shingles. The shingles were in a state of advanced failure in 2002 but had probably failed 15 years after installation, and the rolled roofing became the functional roofing system. The roof suffered from the proximity of trees that inhibited drying of the shingles and added nutrients to the algae and lichen already on the roof. The side-lap shingles were replaced in 2003 with handmade red oak shingles, which were stored and shipped by stacking in a large plywood crate, which helped to prevent drying out (Fig. 10).[3] However, the carpenters installing the shingles said that the shingles on the top of the pile had dried out and cracked when nailed. They were planning to soak the shingles to prevent cracking. All shingles were being hole punched on the job site and were installed without tar paper between courses. Since 2003 the overhanging tree limbs have been cut back to allow more light and air circulation. In 2007 the roof remains in good condition.

At the Morgan Log Home (built c. 1770) side-lap white oak shingles were replaced in 2002 after 26 years of service. When removed and inspected, the shingles were in better condition than expected and could have lasted 5 to 10 more years; tar paper had been used between the courses of shingles. The new roof at the house has tar paper between the courses of white oak shingles. The rows are random widths following the method that had been used on the 1976 roof, which is probably not historically accurate. The new shingles on the Morgan Log Home were thick, and the carpenters had trouble keeping the tips down; they nailed some of the tips to pull the shingles to the lath. The problem with this technique is that future replacement of individual shingles will be difficult.

The shingles of the 1736 Henry Antes House were installed in 1995 without tar paper between the courses, but they are failing because of problems with their manufacture. The shingles were radially sawn and then planed with

Fig. 10. A delivery crate packed tightly with banded bundles, arranged by size, of new red oak shingles for use at the Wright's Ferry Mansion, in Columbia, Pennsylvania.

a handheld 3 1/4-inch planer. Wood with twisted grain was used, and they are warping on the roof. The worst failures are in the shingles that are 8 to 9 inches wide. As of 2006 there were no reported serious leaks.

The replacement shingles at the Hans Herr House (1719) were installed in 1974 with no tar paper between courses. The shingles were the correct thickness (about 1/2 inch). The site staff reported that the roof did not leak but that wind-driven snow would accumulate in the attic. The shingles were replaced in 2003 with machine-sawn shingles, many of which are plain sawn. (Riven shingles consist only of edge, or vertical, grain.) The new shingles change the look of the building and are not a good interpretation. Many of the sawn shingles have cracked, and some were installed with sapwood on the edge, which is rotting. The shingles are all the same size.

On October 13, 2007, the authors observed side-lap shingles at the Bowman Farm in Frederick, Maryland. The date of construction is unknown, but the shingles are protected by the roof of a Federal-style addition. These side-lap shingles bear a red coating that appears to be iron oxide pigment and linseed oil. The shingles are fastened with hand-wrought, spade-pointed nails.

The authors are of the opinion that all of the modern replacement side-lap shingles that have been inspected are too thick. The exception was the Hans Herr House side-lap shingles. The historic shingles observed at Ephrata Cloister, the Pricetown Dunkard Meeting, Wild Goose Farm, and the Bowman Farm match the description given by Robert C. Bucher:

> The long shingle of Eastern Pennsylvania is a thin, tapered shingle. It tapers in both directions from side to side and from butt to tip, and is different from the modern shingle which is uniformly thick across the butt and tapers only in its length…the butts were almost always one-fourth inch thick at the thick, exposed side; however, some unusually wide samples were thicker, as could be expected. The bevel is usually somewhat over one-third the length of the shingle and indicates a 12- to 13-inch exposure, except for the very long ones, which may have had a 16- or 17-inch exposure.[4]

The Pennsylvania Historical and Museum Commission is in the process of replacing side-lap shingle roofing at the Ephrata Cloister, the Landis Valley Museum, and Daniel Boone Homestead. The replacement shingles are red oak and handmade. They vary in length from 42 inches at Daniel Boone Homestead to 34 inches at Landis Valley Museum and Ephrata Cloister. The range of exposed width is 4 to 7 inches. The 42-inch shingles are 5/8 inch thick, and the 34-inch shingles are 1/2 inch thick.

Service Life and Protective Treatments

Ultraviolet light degrades the surface of oak shingles to the point where rain then washes wood fibers off the roof. This form of deterioration can be as serious as that from moisture and organic sources. In the 1700s and 1800s wood shingles were frequently treated in some manner to prolong service life. Herman Phleps, in *The Craft of Log Building,* states that shingles in Europe were smoked to extend the service life and that as late as 1950 shingles could "still be seen stacked for smoking atop the chimneys of huts and cabins in the Alpine meadow region."[5] During George Washington's lifetime the wood shingles at Mount Vernon were painted or stained red. Travelers in Berks County, Pennsylvania, in the nineteenth century, referred to the practice of painting roofs.[6] Colleagues at Parks Canada have reported references to treating shingles with lime water. Sharon Park states in *Preservation Brief 19: The Repair and Replacement of Historic Wooden Shingle Roofs* that

> early roofers believed that applied coatings would protect the wood and prolong the life of the roof. In many cases they did; but in many cases, the shingles were left to weather naturally and they, too, had a long life. Eighteenth-century coatings included a pine pitch coating not unlike turpentine, and boiled linseed oil or fish oil mixed with oxides, red lead, brick dust, or other minerals to produce colors such as yellow, Venetian red, Spanish brown, and slate gray. In the nineteenth century, in addition to the earlier colors, shingles were stained or painted to complement the building colors: Indian red, chocolate brown, or brown-green. During the Greek revival and later in the twentieth century with other revival styles, green was also used. Untreated shingles age to a silver-gray or soft brown depending on the wood species.[7]

The practice of treating shingles, in addition to their being made from denser, old-growth wood, may have contributed to a service life of 60 to 80 years. Modern wood shingle roofing, if treated and maintained, could last 40 to 60 years, 25 to 35 years without maintenance. At Ephrata an oil-based, semi-transparent grey pigmented stain was applied to one of the three-year-old oak roofs. The shingles are not weathering noticeably, and the grey pigment resembles the color of untreated shingles on adjacent buildings. Products used for such an application should contain linseed oil to penetrate and support wood fibers and pigment to block ultraviolet light. Proper maintenance should also include keeping roofs clear of debris and cutting back or removing overhanging trees.

In many cases, the only way to preserve a type of building fabric is to preserve the skill and practice that created it. Adobe plaster and rye-straw thatching are obvious examples; others include wearing surfaces, paint, and masonry pointing. With wood shingles and with other materials cost-cutting substitutions and short cuts rarely work and frequently cause more damage and expense in the long run. From our experience we have concluded that the practitioners of the trades we follow have worked out, over centuries and sometimes millennia, the best methods, and we make substitutions for those materials and methods at the peril of the cultural resources we are paid to preserve.

There has been much speculation as to why side-lap shingles were made a certain way: riven radially, rather than sawn, or laid on the roof in a certain way, side lapped, face nailed with one nail per shingle, stop-chamfered on the thick edge, and prepunched for nailing. Several of these features seem quaint, quirky, or even counterintuitive. Through recovering the craft, sound reasons for most of these features became evident. Riving radially is the most economical way to make shingles with completely straight edge grain. Side lapping is the only way to lay a shingle with a pie-shaped section. Face nailing near the butt is necessary to keep the shingles flat on the roof when there is as much as 18 inches of the shingle exposed to the weather, and having all the fasteners accessible makes repairing roofs easier. Stop-chamfering on the thick edge was the most economical way to remove the sapwood from the weathering portion of the shingle. Prepunching is necessary to prevent splitting a thin hardwood shingle. What we may never know is whether all these features are the product of deliberate design or whether some are merely fortuitous in nature. We do know this: in balancing modern intervention with traditional craft, decisions must be informed by substantial knowledge of the craft, and that knowledge is best gained, and confirmed, through experience.

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Notes

1. Robert C. Bucher, "The Long Shingle," *Pennsylvania Folklife* 18, no. 4 (summer 1969): 51–56. This article was the first study of side-lap shingles and our primary source of basic information. We have worked with Bucher demonstrating shingle making and rye thatching during public events at Daniel Boone Homestead. In many ways we are indebted to him.

2. U.S. Patent No. 11,965, "Shingle Cutting Machine," filed by A. Kendall, Nov. 21, 1854. The advertisement for "Kendall's Patent Double Acting River and Shaver" in the *Ebensburg [Pa.] Democrat and Sentinel,* Jan. 2, 1856, begins, "The attention of Shingle and Lumber dealers, speculators and others, is directed to this invaluable invention, which is now presented to the public as the first and only practical machine extant, for Riving and Shaving Shingles…Various cutting and sawing machines have been invented for making Shingles, but it is a well known fact that Shingles cut or sawed across the grain are quite too flimsy for roofing purposes."

3. David Dauerty had made the shingles using red oak because he was having trouble finding white oak in large quantity. He also consulted, informally, with a materials-science group at the State University of New York, Syracuse, and came to the conclusion that red oak in a roofing application would go through the wetting and drying cycle with less warping than white oak. Formal scientific testing of this thesis has not yet been funded, but the reasoning is that the red oak will soak up moisture more readily and release it more evenly.

4. Bucher.

5. Hermann Phleps, *The Craft of Log Building,* rev. ed. (1950; repr. Ottawa: Lee Valley Tools, Ltd., 1982), 102.

6. Johan Heinrich Jonas Gudehus, "Journey to America" (1829), trans. Larry M. Neff, reprinted in the *Publications of The Pennsylvania German Society* 14 (1980), 307. "The houses of the Americans as well as their farm buildings have wooden shingle roofs that are so thick and solid that a ray of light can come through nowhere. These roofs are painted red, brown or dark blue with oil color and on most of them is to be found a lightning rod…"

7. Sharon C. Park, *Preservation Brief 19: The Repair and Replacement of Historic Wooden Shingle Roofs* (Washington, D.C.: U. S. Dept. of the Interior, 1989), 6.

Glossary

Bolt: Section of a log sized for processing in a shingle brake. A section is usually one-eighth to one-sixteenth section of the log.

Drawknife: A woodworking knife with a handle on each end, usually beveled on one side of the blade. Used with both hands to shape wood clamped in a shaving bench.

Dumb head: The moving (pivoting) part of the shaving bench. It clamps the piece being shaped so that it can be worked with both hands on the drawknife.

Froe: A long blade (6 to 12 inches, or more), wedge-shaped in section, with an eye on one end for the insertion of a perpendicular wood handle or lever. Used to rive bolts of wood into thinner units, such as shingles, fence pales, basket splints, or lath.

Glut: A large wooden wedge used to split large sections of logs apart after they have been cracked with iron or steel wedges. Typically 4 to 6 inches thick, and 12 inches long, or more. Best made of durable, heavy wood, but may be made of any wood at hand. Disposable. Meant to be driven with a heavy root maul. Will shatter if struck with a steel sledgehammer.

Mallet: Wooden club, often made of the root mass of dogwood, elm, or hickory. Used to drive the froe into a bolt to begin riving. Usually weighs 3 to 6 pounds.

Nail hole punch; shingle punch: Lever-actuated tool for prepunching nail holes in hardwood shingles. There are both bench-mounted and free-standing punches, some made from lever-action juice presses.

Riving: Splitting wood with a froe or knife to make shingles, fence pales, basket splints, lath, etc.

Riving brake: Y-shaped tool made from a narrow tree crotch. Once the froe is driven into a bolt, the bolt is jammed into the narrow angle of the brake while the froe is worked (levered) to split the bolt from end to end. Also called a shingle brake.

Root maul: Similar to the mallet but much larger (20 to 30 pounds). The root maul is made from the root cluster of a hickory tree. The tree should be about 6 inches in diameter near the soil line. In making a root maul, the first step is to excavate the earth around the root cluster, tight against the trunk. Next, the surface roots that radiate from the trunk are cut off, and the tree is bent over to expose and cut the taproot. The striking end is shaped with an axe, and the handle shaped with an axe and drawknife. The root maul is used to drive hardwood gluts to split a log.

Sapwood: The band of living wood at the outer edge of the tree; this wood is not mature. It is weaker than the heartwood and has little rot resistance.

Shaving bench: Bench with a seat and a foot-actuated clamp (see dumb head, above.) The woodworker straddles the bench and clamps the work piece with the dumb head while he shapes the work piece with a drawknife or spoke shave. Shaving bench and drawknife are used to shape many kinds of woodwork, including shingles, hay forks, furniture parts, and tool handles. Also called a shaving horse or *schnitzel bank*.

Shingle brake: Riving brake (see above).

Shingle oak: According to Robert C. Bucher the northern red oak subspecies laurel oak *(Quercus laurifolia)* was called the shingle oak in southeastern Pennsylvania. Most field guides list shingle oak as a similar but separate species from laurel oak. Shingle oak *(Quercus imbricaria)* leaves are tawny underneath, while laurel oak leaves are not. Shingle oak is an inhabitant of the Midwest and Ohio Valley, east into the Alleghenies. Laurel oak grows mostly on the southern Atlantic and Gulf coastal plains. The leaves of both are shaped like a laurel leaf. The acorns take two years to mature. We have not used laurel oak or shingle oak to make shingles and cannot comment on any properties that may make it superior for shingle making.

Weathering: Erosion of the wood surface, usually of the softer portions between growth rings and along checks or cracks. Caused by wetting, biological action (fungi, bacteria), and ultraviolet light. Often attributed to the abrasive action of wind-blown debris, but in the humid East this is not a significant factor. What is seldom mentioned is pulp-stripping by nesting wasps and hornets, which, in the authors' experience, is a significant cause of surface loss. On wood fences and roofs, look for a strip of bright wood on the grayed background. At its end will frequently be found a wasp or hornet gathering pulp that has been degraded by wetting and ultraviolet light.